COMPLIANCE MONITORING PLAN

EQUILON SEATTLE SALES TERMINAL

SEATTLE, WASHINGTON

Submitted to

Washington State Department of Ecology

Submitted by

Equilon Enterprises LLC

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CONTENTS

CONTENTS (Continued)

TABLES AND ILLUSTRATIONS

Tables

Figures

1 INTRODUCTION

The purpose of this compliance monitoring plan is to provide procedures to be followed to confirm that cleanup requirements have been achieved at the Equilon Seattle Sales Terminal on Harbor Island in Seattle, Washington. This compliance monitoring plan was prepared consistent with requirements of the Consent Decree between Equilon Enterprises LLC and the Washington State Department of Ecology (Ecology). This plan was also prepared in accordance with the Model Toxics Control Act regulation (WAC 173-340-410, -720, and -820).

This plan has been organized into seven sections as described below:

- **Introduction.** Overviews of the site hydrogeology, cleanup actions, monitoring objectives and rationale, types of monitoring, monitoring locations, and monitoring schedule are provided in this section.

- **Protection Monitoring.** This section discusses criteria for protection monitoring under WAC 173-340-400.

- **Performance Monitoring.** This section discusses performance criteria for product recovery and natural attenuation, product monitoring procedures, sampling and analysis, and schedules for performance monitoring of product and groundwater.

- **Confirmational Monitoring.** This section discusses compliance criteria, monitoring, sampling and analysis, and schedules for confirmational monitoring of groundwater and product.

- **Data Evaluation.** Data validation and evaluation procedures are discussed in this section.

- **Criteria for Meeting Performance and Compliance Standards.** This section discusses criteria to be used to determine if performance and compliance standards have been met. Changes in frequency of monitoring and changes in monitoring locations are also discussed.

- **Reporting.** This section discusses the types and frequency of reports to be submitted to Ecology.

- **Contingency Plan.** This section discusses the steps that will be implemented in the event the proposed cleanup actions are not effective.

1.1 Overview of Site Hydrogeology

Soil underlying the site consists of man-emplaced grade and dredge fill overlying native estuarine deposits (EMCON, 1997). The uppermost grade fill unit consists of coarse-grained fill varying from less than 1 to approximately 2 feet thick. The dredge fill unit originated from estuarine deposits near the site; therefore, delineation of the contact between the two units is difficult. The dredge fill appears to vary from approximately 8 to 20 feet thick at the site. It consists of fine- to medium-grained sand, with some gravel. Native estuarine deposits underlie the dredge fill at depths of approximately 9 to 20 feet. These deposits are composed primarily of fine- to medium-grained sand with thin silt interbeds.

Groundwater occurs as a thin lens of fresh water overlying brackish water at depth. The grade fill is permeable and was unsaturated during the remedial investigation. The water table occurs within the dredge fill 4 to 8 feet below the ground surface. Groundwater within the dredge fill unit occurs under unconfined conditions. The North Tank Farm and Main Terminal areas generally are unaffected by tides; at the Shoreline Manifold Area, groundwater quality and elevations within this unit are affected by surface water tidal fluctuations. The native estuarine deposits are fully saturated and unconfined. Water quality and water elevations within this unit are influenced by surrounding surface water bodies and associated tidal fluctuations. Groundwater within the shallower monitoring zone at the site is estimated to flow radially both to the north and to the south from a potentiometric high located within the Main Tank Farm area.

1.2 Summary of Cleanup Actions

Cleanup actions at the site include source removal and recycling/off-site disposal, monitoring, natural attenuation, and institutional controls. The specific cleanup actions are listed below:

- Continued active and passive product recovery at the Shoreline Manifold Area
- Aggressive passive product recovery at the North Tank Farm
- Groundwater treatment before disposal
- Excavation of accessible total petroleum hydrocarbons (TPH) subsurface soil hot spots above 10,000 milligrams per kilogram (mg/kg) to the extent practicable at the Shoreline Manifold Area

- Excavation of accessible TPH subsurface hot spots above 20,000 mg/kg to the extent practicable adjacent to Tank 31636 in the Main Tank Farm, and east of the warehouse

- Excavation or capping of lead-impacted surface soil above 1,000 mg/kg near the oil/water separator

- Excavation or capping of lead- and arsenic-impacted surface soil above 1,000 mg/kg lead and 32.6 mg/kg arsenic in the Main Tank Farm

- Natural attenuation of residual TPH in subsurface soil

- Product Monitoring

- Groundwater monitoring in point of compliance and property wells

- Institutional controls including a deed restriction

- Contingency plans

1.3 Monitoring Objectives and Rationale

The proposed cleanup actions at the site, as previously discussed in Section 1.2 of this plan, include product recovery, excavation of TPH soil hot spots, excavation or capping of lead- and arsenic-impacted surface soil, product monitoring, and groundwater monitoring. Cleanup areas (areas above cleanup action levels) were identified based on the soil and groundwater chemistry data collected during the remedial investigation (EMCON, 1996).

Types of monitoring, monitoring locations, and types of analyses were selected to monitor the effectiveness of the cleanup actions to meet the soil, product, and groundwater cleanup standards for the site. A brief discussion of site soil and groundwater chemistry data as it relates to monitoring well selection are presented in Sections 1.3.1 and 1.3.2.

1.3.1 Soil

TPH, arsenic, and lead concentrations were above levels requiring action at five locations at the site.

1. **TPH at the Shoreline Manifold Area.** Soil TPH concentrations were above the cleanup action levels (10,000 mg/kg) at the Shoreline Manifold Area.

2. **TPH at the North End of the Main Tank Farm.** Soil TPH concentrations were above the cleanup action levels (20,000 mg/kg inland) adjacent to Tank 31636 at the north end of the Main Tank Farm.

3. **TPH at the East Side of the Warehouse in the Main Terminal.** Soil TPH concentrations were above the cleanup action levels (20,000 mg/kg inland) on the east side of the warehouse.

4. **Arsenic and Lead in the Main Tank Farm.** Surface soil arsenic and lead were above the cleanup levels (32.6 and 1,000 mg/kg, respectively) in unpaved soil in the Main Tank Farm.

5. **Lead at the Oil/Water Separator in the Main Terminal.** Surface soil lead was above the cleanup level (1,000 mg/kg) in unpaved soil adjacent to the oil/water separator.

1.3.2 Groundwater

Groundwater will be monitored for benzene, toluene, ethylbenzene, TPH-G, TPH-D, TPH-O, carcinogenic polycyclic aromatic hydrocarbons (cPAHs), lead, and arsenic in specific areas of the site prior to and during the cleanup action. The selected analysis and monitoring locations correspond to the five soil cleanup actions areas identified in Section 1.3.1, areas of product recovery, and the water quality chemistry data for the site.

Areas Below Cleanup Levels

IHSs were not detected above the groundwater cleanup levels (Table 1-1) more than once in shallow monitoring wells MW-05, MW-102, MW-105, MW-106, MW-107, MW-109, MW-110, MW-112, TES-MW-1, and MW-201; and MW-213 and MW-214. These wells are located at the downgradient side of the North Tank Farm, at the northeast and northwest corners of the Main Tank Farm, across most of the Main Terminal, and at the Shoreline Manifold Area.

Wells Not Included in Compliance Monitoring Program. Monitoring wells MW-106, MW-107, MW-109, and MW-110 will not be included in the compliance monitoring program because of historical IHS detections below the cleanup levels.

Wells Included in Compliance Monitoring Program. Monitoring wells MW-05, MW-102, MW-105, MW-112, TES-MW-1, and MW-201 were also below cleanup levels. These wells will be included in the program due to their location adjacent to areas with soil cleanup actions or to provide a property boundary sentry well network. The fact that the water quality is already below cleanup levels before hot spot cleanup shows that the

proposed cleanup is conservative. Monitoring in these wells will be focused on the IHSs (BTEX, TPH) to provide water quality data for baseline data and trend analysis. These wells will not be monitored for natural attenuation parameters since cleanup levels have been already met in these wells.

MW-213 and MW-214 are two conditional point of compliance wells located at the Shoreline Manifold Area. The two wells are located as close as possible to the area of concern and screened at the bottom of the bulkhead to monitor water quality concentrations at the groundwater/surface water interface or the quality of water entering the Bay. Data collected to date in the well have been below cleanup levels and below the laboratory detection limit, indicating that the interim actions at the Shoreline Manifold Area have been effective. MW-213 and MW-214 will be included in the compliance monitoring program and monitored for BTEX, TPH, and cPAHs.

Areas Above Cleanup Levels

BTEX and TPH Areas. Shallow monitoring wells with periodic or consistent detections of BTEX constituents or TPH above the cleanup levels include MW-101, MW-104, MW-111, TX-03, TX-04, TX-06, MW-202, and MW-203. These wells are located in or around the Main Tank Farm (MW-101, TX-03, TX-04, and TX-06), in the North Tank Farm (MW-202 and MW-203), and in two isolated locations in the Main Terminal (MW-104 and MW-111). Due to the historic detections of petroleum-hydrocarbon-related IHSs above the cleanup levels, these monitoring wells will be included in the compliance monitoring program.

Lead Areas. Dissolved lead was detected periodically above the cleanup level only in MW-104; lead will be included in the analysis of MW-104. Lead will be included in the compliance monitoring program in MW-05, MW-101, MW-104, MW-105, TX-03, TX-04, and TX-06 to monitor the surface soil cleanup action in the Main Tank Farm.

Arsenic Areas. Dissolved arsenic was detected at about two times the cleanup level in TX-06. Arsenic will be included in the compliance monitoring program in MW-05, MW-101, MW-104, MW-105, TX-03, TX-04, and TX-06 to monitor the surface soil cleanup action in the Main Tank Farm.

Areas In or Around Free Product. Shallow wells located in or around a free product plume at the Shoreline Manifold Area include MW-208, MW-210, MW-211, and MW-212. In addition, there are well points WP-1 through WP-8 to monitor product along the bulkhead. Product in these well points have been reduced to a sheen. Trace amounts of free product have also been measured in MW-204 in the North Tank Farm. Product performance and confirmational monitoring will be performed in these wells. The product performance standard is a “measurable product thickness”, and the product

cleanup standard is "no visible sheen." After the performance standard has been met, MW-204 will be sampled for BTEX and TPH.

Off-site Wells Southeast of the Main Terminal. Benzene, toluene, ethylbenzene, and/or TPH-G were detected above the cleanup levels in two off-site wells, A-28 and SH-04, located southeast of the Main Terminal. Dissolved lead was detected in SH-04. These wells are located downgradient of an off-site free-product plume, and the detections above the cleanup levels in these two wells, therefore, represent contaminant migration toward the terminal from an off-site source. They will not be monitored as part of the Equilon compliance monitoring program but will be observed by Ecology for their potential adverse impact to the Equilon Terminal cleanup.

Background

MW-206 is located upgradient to the North Tank Farm and will serve as the site background monitoring well.

1.4 Monitoring Types, Locations, and Schedule

Types of Monitoring. Compliance monitoring will consist of product monitoring, groundwater level monitoring, and groundwater sampling.

- Product monitoring will consist of measuring product levels in areas of the site with floating product on the water table
- Groundwater level monitoring will be performed during product monitoring events and during groundwater sampling events
- Groundwater samples will be collected from compliance monitoring wells and property (sentry) wells on the Equilon site

Monitoring Locations. Figure 1-1 shows the locations of all wells in which product will be monitored, groundwater levels will be measured, and groundwater samples will be collected as part of the site compliance monitoring program. Table 1-2 provides a list of compliance monitoring wells, identifying the well location, monitoring objective, and well use. The monitoring objectives have been categorized as confirmational, performance, and sentry.

- Performance monitoring is to confirm that the cleanup action has attained performance of cleanup standards

- Confirmational monitoring is to confirm the long-term effectiveness of the cleanup action once performance and cleanup standards have been met.

- Sentry monitoring is to provide early warning of off-site contaminant migration.

Table 1-3 provides a summary of the compliance monitoring analytical parameters.

Monitoring Schedule. Groundwater sampling will begin in January 1999 and will continue for five years to January 2004. Sampling will occur quarterly for the first year. Ecology and Equilon will review the data after one year. If trends are declining, the sampling frequency and number of parameters may be reduced.

2 PROTECTION MONITORING

The objective of protection monitoring is to confirm that human health and the environment are adequately protected during all phases of the cleanup action (WAC 173-340-410(1)(a). Protection monitoring will be addressed in the health and safety plan prepared in conjunction with the engineering design report, construction plans and specifications, and operation and maintenance plan (WAC 173-340-400).

3 PERFORMANCE MONITORING

The objective of performance monitoring is to confirm that the cleanup action has attained performance and cleanup standards (WAC 173-340-410(1)(b). Performance monitoring will consist of product monitoring during product recovery activities and groundwater sampling to evaluate the effectiveness of natural attenuation.

3.1 Performance Criteria

The site-specific performance criteria for the respective cleanup options are:

Product Recovery. The performance criterion will be a lack of measurable product thickness in product monitoring wells.

Natural Attenuation. The performance criterion will be periodic demonstrations that natural attenuation is reducing contaminant concentrations at the site (USEPA, 1997). Natural attenuation processes include a variety of physical, chemical, or biological processes that can act to reduce the mass, toxicity, mobility, volume, or concentration of constituents in groundwater. These in-situ processes include biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction of contaminants (USEPA, 1997). Monitoring the effectiveness of natural attenuation requires the collection of constituent plume data (i.e., BTEX and TPH) and a variety of other indicators. Following is the rationale for the selection of the natural attenuation monitoring parameters (from USEPA, 1994c).

Constituent Plume Characteristics

In the absence of natural attenuation mechanisms, constituent concentrations would remain relatively constant within the plume and then decrease rapidly at the edge of the plume. If natural attenuation is occurring, constituent concentrations will decrease with distance from the source along the flow path of the plume as a result of dispersion. If other natural attenuation mechanisms are occurring, the rate at which concentrations of constituents are reduced will be accelerated.

Monitoring of constituent concentrations in the groundwater over time will give the best indication of whether natural attenuation is occurring. If natural attenuation is occurring, the contaminant plume will migrate more slowly than expected based on the average groundwater velocity. Receding plumes typically occur when the source has been eliminated. Natural attenuation may also be occurring in plumes that are

expanding, but at a slower than expected rate. For example, in sandy soils [similar to Harbor Island] with relatively low organic carbon content (about 0.1 percent), BTEX constituents are expected to migrate at one-third to two-thirds of the average groundwater speed velocity (McAllister, 1994). Higher organic carbon content would further retard constituent migration. If constituents are migrating more slowly than expected based on groundwater flow rates and retardation factors, then other natural attenuation mechanisms (primarily biodegradation) are likely reducing constituent concentrations. For stable plumes, the rate at which contaminants are being added to the system at the source is equal to the rate of attenuation. A plume may be stable for a long period of time before it begins to recede, and in some cases, if the source is not eliminated, the plume may not recede.

Occurrence of biodegradation might also be deduced by comparison of the relative migration of individual constituents. The relative migration rates of BTEX constituents, based on the chemical properties, are expected to be in the following order:

benzene > toluene, o-xylene > ethylbenzene, m-xylene, p-xylene

If the actual migration rates do not follow this pattern, biodegradation may be responsible.

Dissolved Oxygen Indicators

The rate of biodegradation will depend, in part, on the supply of oxygen to the contaminated area. At levels of dissolved oxygen (D.O.) below 1 to 2 mg/L in the groundwater, aerobic biodegradation rates are very slow. If background D.O. levels (upgradient of the contaminant source) equal or exceed 1 to 2 mg/L, the flow of groundwater will supply D.O. to the contaminated area, and aerobic degradation is possible.

Where aerobic biodegradation is occurring, an inverse relationship between D.O. concentration and constituent concentrations can be expected (i.e., D.O. levels increase as constituent levels decrease). Thus, if D.O. is significantly below background within the plume, aerobic biodegradation is probably occurring at the perimeter of the plume.

Geochemical Indicators

Certain geochemical characteristics can also serve as indicators that natural attenuation, particularly biodegradation, is occurring. Aerobic biodegradation of petroleum products produces carbon dioxide and organic acids, both of which tend to cause a region of lower pH and increased alkalinity within the constituent plume.

Anaerobic biodegradation may result in different geochemical changes, such as increased pH. Under anaerobic conditions, biodegradation of aromatic hydrocarbons typically causes reduction of Fe^{3+} (insoluble) to Fe^{2+} (soluble), because iron is commonly used as an electron acceptor under anaerobic conditions. Thus, soluble iron concentrations in the groundwater tend to increase immediately downgradient of a petroleum source as the D.O. is depleted, and conditions change to be come anaerobic (i.e., reduced). The concentration of methane increases, another indication that anaerobic biodegradation is occurring.

Oxidation/Reduction Potential

> The oxidation/reduction (redox) potential of groundwater is a measure of electron activity and is an indicator of the relative tendency of a solution to accept or transfer electrons. Because redox reactions in groundwater are biologically mediated, the rates of biodegradation both influence and depend on redox potential. Many biological processes operate only within a prescribed range of redox conditions. Redox potential also can be used as an indicator of certain geochemical activities (e.g., reduction of sulfate, nitrate, or iron). The redox potential of groundwater generally ranges from 800 millivolts to about -400 millivolts... The lower the redox potential, the more reducing and anaerobic the environment.
>
> Measurement of redox potential of groundwater also allows for approximate delineation of the extent of the contaminant plume. Redox potential values taken from within the contaminant plume will be lower than background (upgradient) redox values and values from outside the plume. This is due in part to the anaerobic conditions that typically exist within the core of the dissolved hydrocarbon plume.

Based on this discussion (USEPA, 1994c), groundwater samples collected for natural attenuation evaluation will be analyzed for plume characterization parameters (BTEX, TPH-G, TPH-D, and TPH-O), dissolved oxygen, geochemical indicators (alkalinity, carbon dioxide, total iron (from which ferric iron [Fe^{3+}] can be calculated), ferrous iron (Fe^{2+}), hardness, methane, pH, and sulfate), and oxidation/reduction potential.

3.2 Monitoring and Schedule

Product Recovery. Monitoring wells MW-204, MW-208, MW-210, MW-211, and MW-212, and well points WP-1 through WP-8 will be monitored for the presence of floating product and for potential indicators of product such as odor and sheen. Floating product is defined as a measurable thickness of product (greater than or equal to 0.01 feet thick). Sheen is defined as a visible display of iridescent colors on equipment or water removed from a monitoring well.

An oil-water interface probe will be used to measure product thickness and depth to groundwater. The probe and the water surface in the well will be observed for sheen. If measurable floating product is present, a peristaltic pump or disposable polyethylene bailer will be used to skim floating product from the well.

Product monitoring will be conducted at an interval long enough to allow product to flow into wells in product plumes but no less frequently than once a month. The frequency of product monitoring will depend on the amount and type of product removed from the monitoring wells, the season, and the type of product recovery activity. Product monitoring has historically occurred every two to four weeks, and it is anticipated that this frequency will likely continue.

Natural Attenuation. Groundwater samples will be collected from six monitoring wells at the north end of the Main Tank Farm and in the North Tank Farm for this evaluation. Wells TES-MW-1 and MW-201 will represent groundwater quality upgradient and downgradient, respectively, of a plume of TPH-G and BTEX. Monitoring wells MW-101, TX-03, MW-202, and MW-203 will represent wells in the plume.

Ongoing monitoring will be conducted to confirm the effectiveness of natural attenuation and to estimate the rate. Starting in January 1999, monitoring for natural attenuation will be conducted quarterly for the first year and annually thereafter (USEPA, 1994c).

4 CONFIRMATIONAL AND SENTRY MONITORING

The objective of confirmational monitoring is to confirm the long-term effectiveness of the cleanup action once performance and cleanup standards have been met (WAC 173-340-410(1)(c). Confirmational monitoring will consist of product monitoring and groundwater sampling. In addition, sentry monitoring wells located at the property boundary will be monitored to provide early warning of off-site contaminant migration.

4.1 Product

4.1.1 Compliance Criteria

The compliance criterion for product will be a lack of visible sheen on the water surface in product monitoring wells.

4.1.2 Monitoring and Schedule

Monitoring Wells. Monitoring wells MW-204, MW-208, MW-210, MW-211, and MW-212, and well points WP-1 through WP-8 will be monitored for the presence of floating product and for potential indicators of product such as odor and sheen. Floating product is defined as a measurable thickness of product (greater than or equal to 0.01 feet thick). Sheen is defined as a visible display of iridescent colors on equipment or water removed from a monitoring well.

An oil-water interface probe will be used to measure product thickness and depth to groundwater. The probe and the water surface in the well will be observed for sheen. If measurable floating product is present, a peristaltic pump or disposable polyethylene bailer will be used to skim floating product from the well.

Schedule. Confirmation product monitoring will be conducted once per month for a period of one year after cessation of product recovery activities. The schedule will be reevaluated at that time as discussed in Section 5.2.1.

4.2 Groundwater

4.2.1 Compliance Levels

Groundwater cleanup levels on Harbor Island are based on protection of aquatic organisms and humans ingesting such organisms (Lovely Consulting, Inc., and EMCON, 1997). Accordingly, these cleanup levels are applicable at the groundwater/surface water interface. Table 1-1 presents the groundwater cleanup levels.

4.2.2 Sampling, Analysis, and Schedule

Sample Collection. Groundwater samples will be collected from background monitoring well MW-206, confirmational monitoring wells MW-213 and MW-214, and sentry monitoring wells MW-05, MW-101, MW-102, MW-104, MW-105, MW-107, MW-111, MW-112, MW-201, MW-202, MW-203, TX-03, TX-04, and TX-06 using low flow sampling techniques. After the performance standard has been met, MW-204 will be added to the list of wells to be sampled. Each well will be purged at a low flow rate using the peristaltic pump fitted with disposable polyethylene tubing. Purging will continue until field parameters have stabilized. Groundwater samples will then be collected from the discharge line of the peristaltic pump. A round of groundwater levels will be measured in all available network wells and piezometers before each sampling event.

Sample Analysis. Groundwater samples collected from all wells during confirmational and sentry monitoring will be submitted to a laboratory for analysis of the site petroleum-related IHSs (BTEX, TPH-G, TPH-D, and TPH-O). Additionally, samples collected from wells MW-05, MW-101, MW-104, MW-105, TX-03, TX-04, and TX-06 will be analyzed for total and dissolved arsenic and lead to monitor the surface soil cleanup action in the Main Tank Farm. The samples collected from MW-213 and MW-214 will also be submitted for analysis of cPAHs, which were periodically detected in shallow groundwater at the Shoreline Manifold Area.

Sampling and Analysis Procedures. Detailed procedures for sampling, sampling handling, residuals management, well abandonment, sample analysis, and quality assurance are presented in Appendix A.

Schedule. Confirmational and sentry monitoring will begin in January 1999 and will continue for five years after completion of the cleanup (estimated to be January 2004 based on construction schedules). Sampling will occur quarterly for the first year. Ecology and Equilon will review the data after one year. If trends are declining, the sampling frequency and number of parameters may be reduced.

4.2.3 Well Abandonment

Monitoring wells MW-106 and MW-207 will be abandoned because they are redundant and because no constituents have been detected in these wells above the groundwater cleanup levels. MW-106 is located in the same area as MW-107, MW-108, MW-109, and a series of piezometers. MW-207 is located off site near MW-206.

5 DATA EVALUATION

5.1 Data Validation

All chemistry data will be validated according to United States Environmental Protection Agency (USEPA) data validation guidelines (USEPA, 1994a and 1994b). Data validation will include evaluation of holding times, method blank results, surrogate recovery results, field and laboratory duplicate results, completeness, detection limits, laboratory control sample results, and chain-of-custody forms. A detailed description of the data validation procedures is provided in the sampling and analysis plan (Appendix A). After the data has been validated, it will be entered into the project database with any assigned data qualifiers.

5.2 Data Evaluation

5.2.1 Practical Quantitation Limits

Practical Quantitation Limits (PQLs) will be established for each analyzed constituent to determine whether any are above the corresponding cleanup level. Per WAC 173-340-707(2), if the PQL for any constituent is above the corresponding cleanup level, the cleanup level will be considered to be attained if the constituent is undetected at the PQL or detected below the PQL. The PQL will be determined by multiplying the lowest method detection limit (MDL) obtained by the laboratory for Terminal groundwater samples by a factor of ten (Ecology, 1993). It is anticipated that PQLs will be used as cleanup levels only for the cPAHs.

5.2.2 Product Monitoring Data

Product monitoring data will be reviewed as it is generated to determine the need for product recovery system alterations or to determine changes in product monitoring frequency. Groundwater and product level data will be entered in spreadsheets.

5.2.3 Groundwater Chemistry Data Review

Natural Attenuation Monitoring Data. Natural attenuation monitoring data will be reviewed to see if the data are providing the information needed to evaluate natural attenuation at the site. If the data are not sufficient for the evaluation, Equilon may propose to Ecology adding parameters (Wiedemeier and others, 1995) to the natural attenuation analyte list.

Confirmational and Sentry Monitoring Data. Groundwater chemistry data will be reviewed after it is validated. The data will be compared to the groundwater cleanup levels. If a sample result is above a groundwater cleanup level and also above the historic high concentration in that well, the well will be resampled to verify the result. Resampling will occur within one month of receiving the laboratory data. Groundwater elevation data will be entered into the project database for use in the five year review.

5.2.4 One Year Site Review

Groundwater elevation and chemistry data will be evaluated after the first year of sampling (in 2000). Natural attenuation monitoring well data will be evaluated as discussed in USEPA (1994c; see Section 3.2 above) and Wiedemeier and others (1995). Spatial and temporal changes in plume characterization parameters, dissolved oxygen, geochemical indicators, and oxidation/reduction potential will be evaluated to determine the effectiveness and rate of natural attenuation at the site.

Groundwater TPH and BTEX data will be evaluated using time-trend plots and data comparison to cleanup levels. Time-trend plots will be prepared for each constituent detected above the PQL; trends will be identified by visual observation. The time-trend plots will be used to evaluate long-term trends in the compliance wells and to put the comparisons to cleanup levels in context. A groundwater contour map will be prepared to verify that the groundwater flow directions at the Terminal have not significantly changed.

Ecology and Equilon will review the evaluation. After the first year review, if the sentry wells at the property boundary exceed cleanup standards, Ecology, Equilon, and the adjacent property owner will evaluate groundwater conditions prior to considering contingency plans. If trends are declining, the sampling frequency and number of parameters may be reduced.

5.2.5 Five Year Site Review

Groundwater elevation and chemistry data will be evaluated after five years of sampling (in 2004). Groundwater contour maps will be prepared to verify that the groundwater flow directions at the Terminal have not significantly changed.

Natural Attenuation Monitoring Data. Natural attenuation monitoring well data will be evaluated as described in Section 5.2.4. The evaluation will be documented for presentation in the five-year review report.

Sentry Well Data. Groundwater TPH and BTEX data will be evaluated using time-trend plots and data comparison to cleanup levels. Time-trend plots will be prepared for each constituent detected above the PQL; trends will be identified by visual observation.

Confirmational Well Data. Groundwater TPH, BTEX, and cPAH data will be evaluated using time-trend plots, data comparison to cleanup levels, and, if appropriate, statistical analysis. Time-trend plots will be prepared for each constituent detected above the PQL; trends will be identified by visual observation. The time-trend plots will be used to evaluate long-term trends in the compliance wells and to put the comparisons to cleanup levels, and statistical analyses if performed, in context. If none of the results for an analyte are above the cleanup level, the data for that analyte will not be analyzed using statistics. If at least one result for an analyte is above the cleanup level, statistical analysis per WAC 173-340-720(8) and Ecology (1992, 1993, and 1995) will be conducted.

6 CRITERIA FOR MEETING PERFORMANCE AND COMPLIANCE STANDARDS

6.1 Performance Monitoring

Changes to the product monitoring schedule and wells will be made based on product monitoring data review. Changes may be made in the frequency of product monitoring to maximize product removal or system efficiency, depending on the amount and type of product removed from the monitoring wells, the season, and the type of product recovery activity. Other changes in performance monitoring will be made as follows (Figure 6-1):

- Additional product recovery activities and monitoring will be initiated immediately if a product sheen emanating from the shoreline manifold area is observed on the Elliott Bay water surface.

- An additional well or well point will be installed and monitored if floating product is found for the first time in a downgradient or crossgradient well. The need for additional product recovery activities will also be reviewed.

- Performance monitoring will continue as long as floating product is found in the area being monitored.

- Performance monitoring will end and confirmational monitoring will begin when floating product has not been found in any well in the area being monitored for a period of six months.

6.2 Confirmational Monitoring

6.2.1 Product

Product confirmational monitoring will continue until one of the follow occurs (Figure 6-2):

- Product recovery activities and performance monitoring will resume immediately if a product sheen emanating from the shoreline manifold area is observed on the Elliott Bay water surface

- Product recovery activities and performance monitoring will resume if measurable floating product is found in any well in an area being monitored

- Confirmational monitoring will end and the area considered without floating product when no sheen has not been found in any well in the area being monitored for a period of one year

6.2.2 Groundwater

Changes to the groundwater monitoring program will be based on groundwater quality data review. The review of groundwater quality data will be focused at evaluating groundwater quality trends and not a single event or exceedance in a single well. Changes in sampling will be made as follows (Figure 6-3):

- A well will be resampled if the analyte in the well is above the cleanup level and historic high concentrations

Groundwater quality data will be tabulated and trend plots prepared as part of the one-year site review and five-year site review. If the chemistry results are all below cleanup levels for four consecutive quarters, then Equilon will petition Ecology for site delisting review. Statistical analysis of the data will be performed if there are analytical results above cleanup levels. Alternatively, if the cleanup standards are met for 95 percent of the wells for four consecutive quarters, Equilon will petition Ecology for site delisting review. In addition to reviewing chemistry data for the indicator hazardous substances, natural attenuation parameters will also be evaluated to determine the effectiveness of natural attenuation at the site. The contingency plan (summarized in Section 8 of this Plan) will be initiated if an increasing trend is identified in the five-year review as follows (Figure 6-4):

- The contingency plan will be initiated if there is an increasing trend in the sentry well groundwater quality data and the data exceeds the cleanup level.

- The contingency plan will be initiated if any analyte is consistently above the cleanup level or statistically above the cleanup level with an increasing trend and with no evidence of natural attenuation.

7 REPORTING

Compliance monitoring data will be submitted to Ecology throughout the monitoring program. Ecology will also be notified immediately if product sheen emanating from the shoreline manifold area is observed on the Elliott Bay water surface. Data will be submitted in the following reports:

- **Quarterly Data Reports.** Laboratory data reports will be submitted to Ecology after each round of laboratory data has been received.

- **Annual Data Reports.** An annual data report will be prepared. The data report will include a data validation memo, updated groundwater chemistry tables (including any well resampling results), and product recovery data for the previous year. Any changes in the product recovery system will also be discussed.

- **Five-year Review Report.** A report will be submitted to Ecology summarizing the five-year review of the compliance monitoring data. The report will include an updated groundwater elevation table, a representative groundwater contour map, time-trend plots for analytes detected above the PQL, a comparison of the data to cleanup levels, and a discussion of natural attenuation.

8 CONTINGENCY PLAN

A contingency plan is a cleanup technology that serves as a "backup" remediation technology in the event that the preferred option fails or proves ineffective in a timely manner (five years after implementation of the preferred option). A contingency plan will be triggered and implemented within 30 days of meeting any of the following criteria:

- The results of the groundwater monitoring program indicate elevated contaminant concentrations over the specified restoration time frame of five years after implementing the preferred corrective options

- Contaminants are identified in point of compliance wells located outside of the original plume boundary, indicating renewed contaminant migration

- Contaminant migration is not decreasing at a sufficient rate to ensure that the primary and secondary concerns identified for the site are being met

The following actions will be initiated if the above criteria are triggered:

- Identify the source(s) causing the criteria to be triggered. For example, at the Shoreline Manifold Area, an increasing trend could indicate a new release. The highest priority in the compliance plan would be to identify and control the source.

- Remove the source (e.g., impacted soil) or implement appropriate treatment (e.g., adding oxygen releasing compounds), as needed, to the extent practicable. For example, additional hot-spot soil at the Shoreline Manifold Area will be excavated to the extent practicable when the underground pipelines are relocated above ground. Sources will be removed as long as removal does not impact the integrity of existing structures or create a greater environmental hazard.

- If residual product is identified beyond the capture zone of the existing product recovery network, the network will be evaluated and expanded to ensure removal of free product from the water table.

- If the results (increasing trend in surface water quality in point of compliance wells and a significant new product release at the Shoreline Manifold Area) indicate there has been potential environmental impacts to aquatic organisms in

Elliott Bay, then sediment and bioassay sampling will be implemented in accordance with the procedures outlined in the State of Washington Sediment Management Standards.

LIMITATIONS

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, nor the use of segregated portions of this report.

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TABLES

FIGURES

APPENDIX A

COMPLIANCE SAMPLING AND ANALYSIS PLAN

Table 1-1

Groundwater Cleanup Levels
Equilon Seattle Sales Terminal
Seattle, Washington

Constituent	Cleanup Level (mg/L)
Benzene	0.071
Benzo(a)anthracene	0.000031
Benzo(a)pyrene	0.000031
Benzo(b)fluoranthene	0.000031
Benzo(k)fluoranthene	0.000031
Chrysene	0.000031
Ethylbenzene	0.43
Indeno(1,2,3-cd)pyrene	0.000031
Lead	0.0058
TPH-G	1
TPH-D	10
TPH-O	10
Toluene	5.0